

LCMR WORK PROGRAM 1991

I. Traffic Signal Timing and Optimization Program

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M.L.91 Ch.254 Art.1 Sec.14 Subd:13(a)

Appropriation:	\$	1,175,000
Obligated Funds TO-DATE:	\$	1,173,580
Account Free Balance of Appropriation:	\$	1,420

Traffic Signal Timing and Optimization Program: This appropriation is to the Commissioner of Administration for transfer to the Commissioner of Transportation. \$125,000 is for traffic signal retiming and optimization training and \$1,050,000 for a cost share program for signal retiming. \$675,000 of the cost share program is available only as cash flow permits.

II. Narrative

It is estimated that there are close to 2,500 traffic signals on state, county and city roads in the state of Minnesota. For many of these traffic signals, particularly in rural areas, the timing was established when the signals were first installed and in most instances the timing has never been readjusted for changing traffic volumes and patterns. Traffic signals have a dominant influence and significant impact on the traffic flow and energy efficiency of Minnesota's transportation system. This program will begin to address the problem by; conducting an inventory and needs survey of the state's signal systems, evaluating the signals and proposing recommendations to retime and/or upgrade signals where necessary, prioritizing signals which could benefit from a retiming effort, implementing a grants program to retime and optimize the high priority signals throughout the state and training county, city and state traffic engineer personnel in the state-of-the-art signal timing techniques.

III. Objectives

A. TECHNICAL TRAINING / TECHNOLOGY TRANSFER

A.1. NARRATIVE:

Technical seminars and workshops will train and educate city, county and state traffic engineering personnel in: the benefits of traffic signal retiming and coordination; criteria for installation of various types of traffic signal systems; signal plan design; signal phasing and detector placement; use of traffic signal timing software and timing optimization techniques; traffic signal maintenance. Workshops, a software Users Group and newsletters will also give traffic engineering personnel throughout the state the opportunity to exchange information and ideas on traffic signal design and operation.

A.2. PROCEDURES:

There will be three one-week workshops and a software Users Group offered to city, county and state traffic engineering personnel. These courses will cover traffic signal design and operation. A qualified traffic engineering consultant will be retained to conduct these courses.

Course 1A - Traffic Signal Operation; Optimizing Isolated Signals
Course 1B - Traffic Signal Operation; Optimizing Interconnected Signals
Course 2 - Traffic Signal Design
Users Group for Signal Timing Software

The Software Users Group will focus on traffic signal timing and optimization. State and Local traffic engineers will exchange information on signal optimization efforts through a newsletter published and distributed by Mn/DOT's Traffic Engineering Office. Papers prepared by participants (as well as other states) will present and discuss their signal optimization programs.

A.3. BUDGET:

	BUDGETED:	ENCUMBERED:
LCMR Funds:	\$125,000	\$125,000
Funds transfered to Opt. Program		(2,430)
* Federal 402 Safety Funds:	20,000	20,000
* Mn/DOT's Consultant Agreements Funds:	23,175	23,175
TOTAL BUDGET:	\$168,175	\$165,745
Funds Encumbered TO-DATE:		165,745
BALANCE of AVAILABLE FUNDS:		\$ 0

NOTE:

- * All costs exceeding the original \$125,000 LCMR funds have been covered through either Federal 402 Safety Funds or Mn/DOT's Consultant Agreements Budget.

A.4. TIME LINE:

	Jul91	Jan92	Jun92	Jan93	Jun93
Develop Courses:	*****			*****	
Conduct Course 1		*A* *B*			
Conduct Course 2			***		
Conduct Course 1 (repeat)				*A* *B*	
Conduct Course 2 (repeat)					***
Conduct Users Group		*****	into future		

A.5. STATUS REPORT:

July 1, 1991:

First status report due January 1, 1992

January 1, 1992:

Consulting firms have been selected and placed under contract. Course content has been determined and course materials are being prepared. The dates for the courses have been set for the 1992 offering, but the 1993 dates are still unknown. It is anticipated that approximately 58 people will attend Course 1A & 1B and 70 people will attend Course 2. Additional funding is being sought from Federal 402 Safety Funds. If found to be eligible, the program will receive \$20,000 from these 402 Funds towards the cost of Course 2 - Signal Design.

July 1, 1992:

The Technology Exchange has changed format, from an anticipated one time seminar to an ongoing users group for traffic personnel responsible for the timing of traffic signals. A newsletter will be published and distributed (possibly quarterly) to all people who attended the course(s). The cost for the newsletter, its distribution and the user group will be completely covered by Mn/DOT without the use of LCMR funds.

Federal 402 Safety Funds were approved for the Signal Design Course as requested. They were received and utilized prior to July 1, 1992. Additional funding may be requested from this source for FY 1993.

January 1, 1993:

The training courses (workshops) have been advertised for the 1993 sessions. An overwhelming response for registration has the courses filled for 1993. Preparation has begun between Mn/DOT and the consultants for any changes to the next classes.

Approval for funding from Federal 402 Safety Funds for FY 1993 is still pending. Mn/DOT has approved the use of up to \$25,000 (minus 402 Fund participation) for the FY 93 presentation of these courses.

July 1, 1993:

The second year of training courses (workshops) were conducted in February and March of 1993. Traffic personnel from state, county and city agencies participated in the courses. State-of-the-Art signal timing software was distributed to each agency in addition to the classroom hands-on training for each of the software packages.

Federal 402 Safety Funds were not available for the 1993 courses, so all additional costs have been covered through the Mn/DOT Consultant Agreements Budget at an estimated amount of \$23,175.

January 1, 1994:

No further training has been conducted during this time period, but Mn/DOT is planning on providing additional training courses in the future at Mn/DOT's expense.

A.6. BENEFITS:

The workshops and software users group will enhance the knowledge and capabilities of traffic engineering personnel to manage and operate their traffic signals more effectively with state-of-the-art procedures and techniques. This will lead to a more efficient and effective transportation system which will benefit the driving public.

B. SIGNAL RETIMING and OPTIMIZATION PROGRAM

B.1. NARRATIVE:

The focus of this objective is the development and implementation of a state wide traffic signal optimization program which will improve the energy efficiency of Minnesota's transportation network. This will be a grants program whereby cities, counties and the Minnesota Department of Transportation may submit projects for funding. Each agency may use the funds to either retain a traffic engineering consultant, or supplement their workforce, as necessary, to collect and analyze data; develop retiming and optimization plans for the project. Agencies will be required to share in funding and grant funds can not be used for traffic signal hardware or construction costs. In addition, a survey of all traffic signal systems within the state will be conducted. Based on this data, the statewide existing traffic signal systems will be evaluated and the potential for statewide optimization benefits will be analyzed.

B.2. PROCEDURES:

The primary task of this objective is to begin to implement a statewide traffic signal optimization program. Qualified traffic engineering consultants will be retained to accomplish these tasks for state and local agencies as necessary. A statewide signal survey will be conducted such that the magnitude of the program may be assessed. Tasks to accomplish:

1. Conduct state wide survey of traffic signals
2. Evaluate potential improvement from retiming effort
3. Evaluate potential improvement from signal system upgrade
4. Develop and implement a grants program to retime and optimize traffic signals on a statewide basis (retime approx. 700 signals, approximately 1/4 of the signals in the state).

- 5. Provide a marketing plan to show and sell the benefits of the program to the agencies and how to apply for the grants.
- 6. Evaluate and publicize the results of each project and provide a final report of the statewide signal retiming and optimization program

B.3. BUDGET:	
LCMR Funds Appropriated:	\$ 1,050,000
LCMR Funds Transferred from Training:	\$ 2,430
Total Available LCMR FUNDS:	\$ 1,052,430
LCMR Funds Obligated TO-DATE:	\$ 1,051,010
* Local & State Cost Share TO-DATE:	\$ 333,706
Note: Cost sharing will NOT be received directly into Budget.	
** Total Funds Programmed for Projects TO-DATE:	\$ 1,384,717
LCMR Funds Account Free Balance:	\$ 1,420

- NOTES:
- * The exact total dollar amount of agency cost sharing will not be determined until the agencies submit Final Reports for their projects.
 - ** Funding for all the optimization projects has been encumbered and all the projects have been placed under contract.

B.4. TIME LINE:	Jul91	Jan92	Jun92	Jan93	Jun93
Conduct Signal Inventory - Task 1	*****				
Evaluate Signal Systems - Tasks 2,3		*****			
Develop and Implement Grants Program - Task 4,5		*****			
Evaluation and Reports - Task 6		*****			
					-> Final Report Jan.'94

B.5. STATUS REPORT

July 1, 1991:
First status report due January 1, 1992

January 1, 1992:
The program has received a name: The Mn/SOTA Program which stands for Minnesota Signal Optimization & Timing Assistance. A steering committee was established consisting of Mn/DOT, City of St. Cloud, and Anoka County representatives. Due to the late receipt of LCMR funds (received into Mn/DOT accounts in late October 1991), it was necessary to initiate a statewide signal inventory with Mn/DOT staff rather than hiring a consultant. With this change, we reduced the scope of the inventory to only a general survey regarding age and type of equipment, number of intersections signalized, type of coordination utilized, and information regarding the agency's practices of retiming signals. We feel that this down-scoping of the inventory will still provide the

program with valuable information to be used for future planning of the program, although prioritizing in procedures 2 and 3 will be limited.

Four consulting firms have been selected and placed under contract to perform optimization projects for State owned signal systems. These contracts allow the State to request the consultant to perform any or all the necessary tasks required to perform the project, including data collection, analysis, implementation, study reports of before/after conditions, and the calculation of benefits from the project.

Brochures have been designed and printed for the Mn/SOTA Program. The cost of the design and printing have been paid by Mn/DOT (as well as all other administrative costs of the program). The brochures and other program information was mailed to all cities and counties within Minnesota, and distributed to all Mn/DOT Districts.

An orientation meeting was conducted on October 3, 1991, which invited all State, city and county Traffic Engineers to attend. This meeting explained the Mn/SOTA Program, handed out application forms and program brochures, and answered questions regarding the program.

The funding has been split into Metro Area vs. Outstate and each of these regions split into State vs. Local funding. This funding split only dedicates funds until April 1, 1992, at which time unprogrammed funds may be utilized by another region or agency level. This system allows the outstate area to compete against the metro area for program funds, but a sunset date allows the program to shift funds to match needs in a timely manner.

Many state, city and county agencies have sent in project applications. Due to the late start of the program (receipt of funds), no projects were started in the fall of 1991 as originally anticipated, but many projects should be ready for an immediate start in early spring. It appears from early applications, that the average cost of optimization projects may be higher than originally anticipated which will reduce the total number of signalized intersections which are retimed by the program's funding. Since most of the costs are still speculative, we can not predict the number of signals the program will be able to retime.

July 1, 1992:
We have changed the 'Technology Exchange Seminar' as originally proposed to an USERS GROUP for Signal Timing Software. This will provide for an ongoing communication between the various agencies versus a one-time seminar. The first newsletter has been distributed and, dependent upon interest, will be published quarterly. The users group, any meetings, and the newsletter will be funded directly by Mn/DOT without the use of LCMR funding.

To-date the Mn/SOTA Program has initiated 16 contracted projects totaling 148 signalized intersections. Another 178 intersections may be placed under contract soon. Of the total of 148 intersections, 48 (7 contracts) signals are state operated signals vs. 100 (9 contracts) which are locally operated. Cost proposals for signal optimization have been averaging \$2500± per intersection TO-DATE, but this may not be representative for future projects since each differs in regards to travel costs and data required to be collected.

None of the contracted projects have been completed TO-DATE, therefore no Final Reports have been received yet. Preliminary findings, learned through discussions with program participants, show that results are very promising for high benefit/cost ratios.

January 1, 1993:
To-date the Mn/SOTA Program has initiated 33 contracted projects totaling 525 signalized intersections. Another 101 intersections may be placed under contract soon. Of the total of 525 intersections, 120 (18 contracts) signals are state operated signals vs. 405 (12 contracts) which are locally operated. Cost proposals for signal optimization have

continued to average \$2500± although the overall average per intersection has dropped to \$2000±. The reduction of average cost was largely influenced by 2 large CBD projects (both St. Paul and Minneapolis).

Drafts of Final Reports have started to be received by the Mn/SOTA Program. Initial results appear to be excellent. The best cost benefit ratio reported to-date was 56 to 1 on a project conducted in St. Cloud (based upon a saving to motorists in STOPS, FUEL, and TIME). This project paid for itself in less than a week. Other projects have not been as dramatic, but positive savings have been found in all projects to-date.

July 1, 1993: THIS IS NOT A FINAL REPORT AT THIS TIME

To-date the Mn/SOTA Program has initiated 46 contracted projects totaling 637 signalized intersections. Of the total of 637 intersections, 168 (23 contracts) signals are state operated signals vs. 469 (23 contracts) which are locally operated.

Final Reports are being received by the Mn/SOTA Program. Results continue to appear to be excellent. With only 16 projects reported to date, for a total of 123 signalized intersections, the cost benefit ratio is averaging 33 to 1 (based upon a saving to motorists in STOPS, FUEL, and TIME).

The Mn/SOTA Program has received an extension from the Department of Administration for the completion of the Final Report. The new end-date is February 28, 1994. We will submit an additional semiannual the final report on January 1, 1994.

January 1, 1994:

Although some final results have not yet ready to be calculated from several projects, to-date we have calculated a total of 3.7 million gallons of fuel saved, 168 million fewer stops and 2.8 million hours of travel time saved. These totals will increase when all calculations are completed. The **Benefit/Cost** ratio, to-date, per optimized signal has averaged **58 to 1** (based upon a saving to motorists in **Fuel, Stops and Time**).

B.6. BENEFITS:

The timing on many of these signals was established when the signals were initially installed and has never been readjusted for changing traffic patterns and volumes. The benefits realized through this retiming and optimization program will be: reduced fuel consumption; reduced delays and stops; reduced vehicle emissions and air pollution; reduced traffic congestion; reduced vehicle operating costs, increased driver respect for traffic control devices and increased safety. This will lead to a more efficient and effective transportation system which will benefit the driving public.

IV. Evaluation

This program will lead to a more efficient and effective Minnesota transportation system and will have a positive direct impact on the driving public. The benefits to all of Minnesota will be realized through: reduced fuel consumption; reduced delays and stops; reduced vehicle emissions and air pollution; reduced traffic congestion; reduced vehicle operating costs and increased safety. All of these benefits can be predicted and evaluated using computer models. Also, before and after studies will be done to evaluate individual projects. Benefit/Cost will be calculated for each project and the program as a whole.

V. Context: Related Current and Previous Work

- A. There is no statewide program underway to address signal timing and optimization. This is largely due to light budgets, limited staff and a heavy daily workload at city, county and state traffic engineering offices, making it difficult or impossible to undertake the necessary effort on their own. There is also, currently, a lack of technical expertise in

these offices. This program will begin to address these problems.

- B. To date, some signal optimization has been accomplished in the Metro District of the Department of Transportation. This work has been on spot corridors and lacks in covering the total system and realizing the full potential benefit of signal retiming and optimization. This is largely due to limited staff and light budgets. The program will complement and help fully realize the benefits of signal optimization. On a national level, other states (California, Illinois, Iowa, North Carolina, Wisconsin, etc.) have traffic signal optimization programs. This program will complement national programs and include Minnesota with the states that are using state-of-the-art technology to reduce congestion and fuel consumption.
- C. No past LCMR funds have been received or used for traffic signal retiming and optimization. Although it is anticipated that additional funding beyond the FY92-93 biennium will be sought through LCMR, Mn/DOT will continue to fund signal retiming and optimization projects on a limited basis for state operated signal systems beyond the FY92-93 biennium. Mn/DOT's funding will be through its Consultant Agreements Budget as monies are available.
- D. Not applicable.
- E. Biennial Budget System Program Title and Budget: Not available at this time.

VI. Qualifications

- 1. Program Manager: Marvin L. Sohlo, PE
Signal Operations Engineer
Minnesota Department of Transportation
He has 16 years experience working in the Minnesota Department of Transportation. He has been in the position of Signal Operations Engineer since February of 1991. Previous to this time, he worked for three years as the Assistant Consultant Agreements Engineer for Mn/DOT where he administrated the annual consultant budget of approximately \$18 million annually.
- 2. Steering Committee Chair: Curtis L. Gobeli, PE
Traffic Signals Engineer
Minnesota Department of Transportation
He has 20 years experience working in the Minnesota Department of Transportation. During the last 12 years he has been directly involved in the traffic engineering field working with traffic signals. He has experience in design, construction, operation and the maintenance of traffic signals.
- 3. Cooperators/other Investigators: Traffic engineering consultants will be retained to administer the project, provide for the technical training/technology transfer and for doing the work for the agencies that receive the grants. Consultants will not be selected until the program is approved and begun on July 1, 1991. Mn/DOT will be the selecting agency for administering the project and the technical training/technology transfer. The agencies receiving grants will select consultants to do the grant work.

VII. Reporting Requirements

Semiannual status reports will be submitted not later than January 1,1992, July 1,1992, January 1, 1993, July 1, 1993, and a final status report by January 1, 1994.

JAN 3 1994

1991 RESEARCH PROJECT ABSTRACT

FOR THE PERIOD ENDING JUNE 30, 1993

This project was supported by Oil Overcharge Money in the Special Revenue Fund

TITLE: Traffic Signal Timing and Optimization Program
PROGRAM MANAGER: Marvin L. Sohlo P.E.
ORGANIZATION: Minnesota Department of Transportation
LEGAL CITATION: M.L. 91, Ch. 254, Art. 1, Sec. 14, Subd. 13(a)
APPROP. AMOUNT: \$ 1,175,000
EXPENDITURES: \$ 122,569 - Training \$ 1,051,011 - Assistance \$ 1,420 - Returned

STATEMENT OF OBJECTIVES

Traffic signals have a significant impact on the traffic flow and energy efficiency of Minnesota's transportation system. There are 2,700± traffic signals within Minnesota. Timing for many of these signals was established when first installed and never readjusted for changing traffic volumes and patterns. The general lack of timing revisions were due to the great amount of data collection and long analysis necessary in order to optimize the signal properly. It has been difficult for all agencies to dedicate time and funds to an apparently "operating" signal, when many new signals and associated problems are being added annually. This program addressed the problem by providing training to county, city and state traffic engineering personnel in the state-of-the-art computerized signal timing techniques and by implementing a grants program which provided funding for the retiming and optimization of many of the signal systems throughout the state.

OVERALL PROJECT RESULTS

SIGNAL OPTIMIZATION TRAINING and SIGNAL DESIGN TRAINING:

Fifty-nine county, city and state traffic engineering staff were trained in the computerized state-of-the-art signal timing procedures. Each participating government agency was supplied with a copy of the necessary computer software programs which will enable them to continue to monitor their signal systems' efficiency and make adjustments in the future. Participating agencies included: 5 metro counties, 10 cities, and Mn/DOT, representing the majority of agencies within the state which operate signals and maintain/upgrade the signal timing plans.

Fifty-five county, city and state traffic engineering staff in the latest State of Minnesota standards, policies, and generally accepted national practices for the design and construction of a traffic signal. Each participant received a two volume manual of collected Mn/DOT standards, policies, guidelines, typicals, and example plans for signal design. This training will promote the standardization of signal design statewide. Participating agencies included: 4 metro counties, 5 cities, and Mn/DOT, representing the majority of agencies that design and produce signal construction plans.

SIGNAL OPTIMIZATION and TIMING ASSISTANCE Program:

A funding program called Mn/SOTA (Minnesota Signal Optimization and Timing Assistance) was developed to provide financial assistance to county, city and state agencies for the re-timing of existing signal systems. The program provided \$1,051,011 with matching funding from agencies of \$333,706 for a total of \$1,384,717 being spent on the re-timing of signalized intersections. Signalized intersections without an approach leg on a state highway were funded with a 50% local match. Forty-eight re-timing projects (20 state and 28 local) were conducted, for a total of 637 signals (139 state operated and 498 local agency operation).

Benefits for the optimization were calculated using a nationally utilized software program called TRANSYT-7F. The benefits were based upon three MOE's (Measures Of Effectiveness): **fuel consumption** (extra fuel while idling and accelerating), **vehicle stops** (wear & tear due to braking and idling) and **vehicle delay** (extra travel-time due to signal stops). Total reductions to-date of 3,742,000 gallons of fuel, 168,372,000 vehicle stops, and 2,836,000 hours of delay time were calculated (only 262 signals have final savings reported to-date). Values for these MOE's were set at: \$1.00 per gallon of fuel, \$0.014 per vehicle stop, and \$10.00 per hour of vehicle delay. Results to-date have averaged **58:1 B/C Ratio** (Benefit/Cost per signal) based upon only one year's worth of savings (although a retimed signal should usually provide efficient operation for 3± years in an urban setting, 5± years rural). The B/C Ratios ranged from 1:1 to 290:1 depending upon many factors not yet quantified.

PROJECT RESULTS USE AND DISSEMINATION

The program has awakened the traffic operations community that their signals should be re-analyzed periodically and proven that analysis has become relatively easier due to computerized methods. A user support group of training participants has been formed such that agencies may exchange new techniques. A newsletter may be produced. Results of the projects are being reported and compiled into spreadsheet. Results of the total program, when fully analyzed, will be reported to all participating agencies via a summary report and at the annual meeting of MUTECH (Minnesota Urban Traffic Engineers Council). A copy of each project report and the summary report will be given to the MN State Legislative Library when available. Relationships between project characteristics and benefits will be analyzed for estimating B/C Ratios of future signal improvement/upgrade projects.